TOWARDS DEVELOPING ECOLOGICAL NICHE MODELS FOR PELAGIC SEABIRDS: PHASE I

Kate Ingenloff[1,2]
[1]Biodiversity Institute, University of Kansasas, Lawrence, KS, USA
[2]Department of Ecology & Evolutionary Biology, University of Kansas, Lawrence, KS, USA

INTRODUCTION

Global pelagic seabird populations are declining as a result of a multitude of natural and anthropogenic factors. Ecological niche modelling (ENM) can provide critical insights into a species' niche even when only basic occurrence data are available; historically, however, these methods have seen limited success for highly mobile species. Here I present the results of the first phase in developing functional ENMs for these species through parameterization of three algorithms to assess their ability to predict seasonal environmental preferences for non-breeding Wandering albatrosses (*Diomedea exulans* Linnaeus, 1758). The complex behavioural biology and high mobility of pelagic seabirds make them an ideal study group for this project.

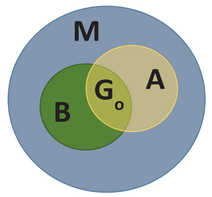
DATA

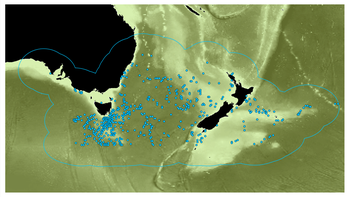
Observational Data: langrangian (observation) data for all Procellarids (Global Biodiversity Information Facility[1]).

Environmental Data – Dynamic: 7 variables, MODIS Terra 4.6km Monthly L3 SMI[2]. ***– Geophysical:*** ETOPO1 Global Relief data[3]; further processed to produce an additional layer (bathymetry slope).

MODEL TRAINING

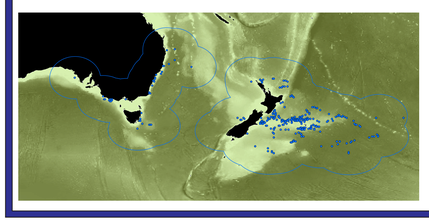
M - Model Calibration Region:
Biotic-Abiotic-Mobility (BAM) framework[5] in context with *D. exulans* (right). M is not a limiting factor, thus M's were delineated using a 500km buffer based upon completeness of environmental representation by season.

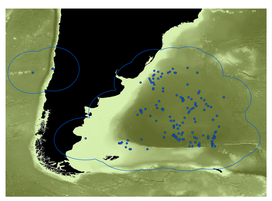




Calibration regions (blue polygons) and training occurence data (blue points) for *D. exulans* by season.

Left: Season 'I'
Bottom Left: Season 'G'
Bottom Right: Season 'P'





MODEL CALBRATION & PARAMETERIZATION

D. exulans observation data used in model calibration and testing by season.

Season	M Train	M Test	Proj Region Test
I	556	239	269
G	281	121	185
P	140	60	130

Presence-Only Models:

Maxent (v3.3.3k[6]**):** 100 bootstrapped replicates, 30% random test, 1000 max iterations. Initial sensitivity analyses identified ideal combination of environmental variables for model calibration. Runs per season: 39.

Minimum Volume Ellipsoids (MVE): calibrated over 6 levels of variable inclusion for 3 thresholds in R v3.2.2[8]. Runs per season: 18.

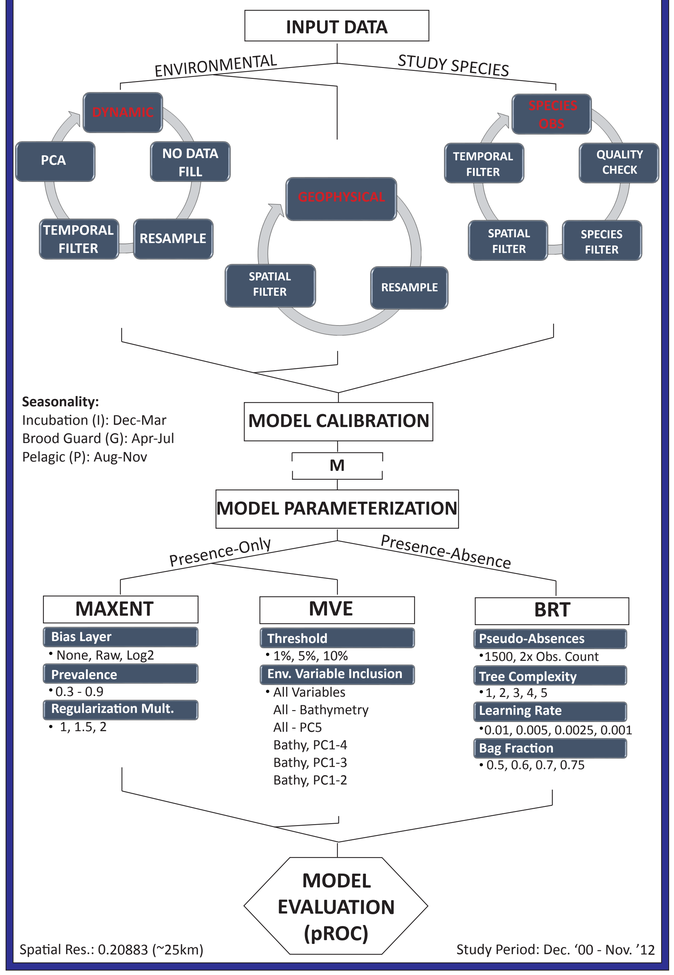
Presence-Absence Models:

Boosted Regression Trees (BRT): calibrated using 7 environmental variables to a minimum of 1000 trees in R v3.2.2[8]; scripts were modified from Elith et al (2008)[10]. Runs perseason: 160.

MODEL TRANSFER

Calibrated niche models were projected to a standardized region of the Southern Hemisphere (-20˚S to -60˚S latitude).

D. exulans MODELING 'WORKFLOW': Phase I



Seasonality:
Incubation (I): Dec-Mar
Brood Guard (G): Apr-Jul
Pelagic (P): Aug-Nov

Spatial Res.: 0.20883 (~25km)

Study Period: Dec. '00 - Nov. '12

MODEL EVALUATION

The non-parametric partial ROC (pROC) metric (omission threshold 5%, 2000 iterations) was used as an indicator of model performance for each (1) calibration region and (2) projection region. Scores were calculated in R v3.2.2[8] .

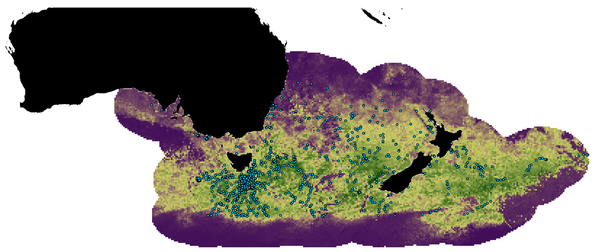
RESULTS - OVERVIEW

Maxent: produced the best calibrated models for all seasons; exhibited difficulty with model transfer in season 'I'.

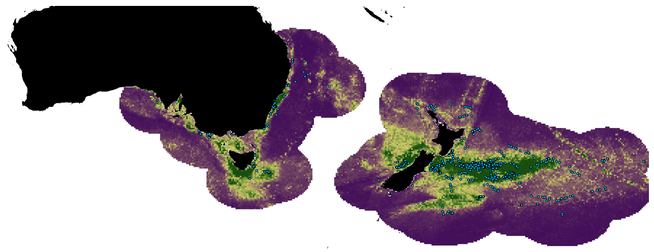
MVEs: did not yield any models with the largest mean pROC for any season; pROC scores indicated performance consistently better than random (pROC > 1) across all parameterizations and seasons, indicating better performance potential overall.

BRTs: severely overfit during model interpolation and projection; thus, were not explored further.

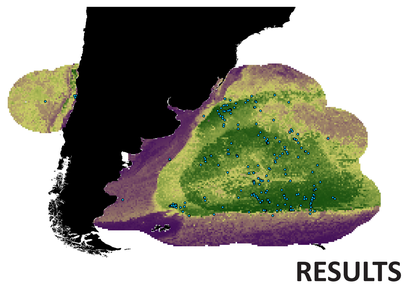
RESULTS - MODEL CALIBRATION
(a.k.a. 'SDM' or 'HABITAT MODELING')



Left: Season 'I' "Best Model Calibration":
Maxent: Prevalence - 0.3
Regularization Multiplier - 1.5
Bias Layer - None
pROC - 1.1757

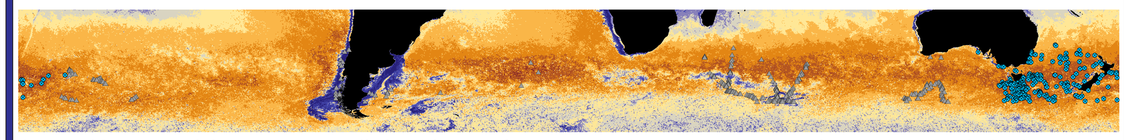


Right: Season 'G' "Best Model Calibration":
Maxent: Prevalence - 0.3
Regularization Multiplier - 1
Bias Layer - None
pROC - 1.2454

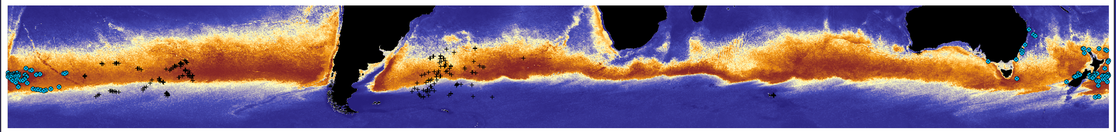


Left: Season 'P' "Best Model Calibration":
Maxent: Prevalence - 0.4
Regularization Multiplier - 1.5
Bias Layer - None
pROC - 1.1710

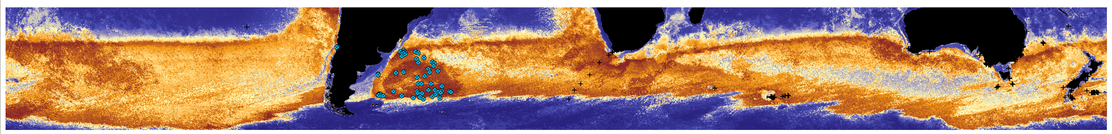
RESULTS - MODEL TRANSFER
(a.k.a. 'ENM')



Season 'I'. Best model output across all algorithms and paramterizations -- Maxent: Prevalence - 0.7, Regularization Multiplier - 2, Bias - Log2 (w/ kernel smoother). Raster output with 'stretch' display clipping 0.5% of maximum and minimum extremes. Black "x"s denote test observation data.



Season 'G'. Best model output across all algorithms and paramterizations -- Minimum Volume Ellipsoid: Threshold 10%, Run2. Raster output displayed using 10 classes of quantiles. Black triangless denote test observation data.



Season 'P'. Best model output across all algorithms and paramterizations -- Maxent: Prevalence - 0.9, Regularization Multiplier - 1, Bias - None. Raster output with 'stretch' display clipping 0.5% of extremes. Black "x"s denote test observation data.

DISCUSSION

Present implementations of ENM techniques are inadequate for reconstructing and predicting the realized niches of highly mobile species; unfortunately, projected climate change is likely to significantly impact pelagic seabirds in particular. Seabirds have a complex behavioural biology, and though migration strategies are often generalized, there high individual variation exists within populations in addition to habitat partitioning across populations. Improving current methodologies to maximize the predictive power of ENM techniques fcan significantly enhance our understanding of the ramifications of climate change. Improved insight into the macroscale factors driving the distributional dynamics of pelagic seabirds (and other highly mobile species) combined with increasing knowledge of species' ecology can provide critical information for conservation planners.

PHASE II

- Incorporate behavioural biology (e.g., individual specialization) and population level habitat partitioning
- Eularian (tracking) data for model calibration
- Refine predictor variables
- Refine spatial and temporal resolutions

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CONTACT INFORMATION

Kate Ingenloff
Biodiversity Institute, University of Kansas
kate.ingenloff@ku.edu
C-CHANGE